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ELECTROCONDUCTIVE TITANIUM OXIDE, MANUFACTURING METHOD THEREOF, AND PLASTIC COMPOSITION CONTAINING SAME

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Abstract

Problem to be solved by the invention

To provide a type of electroconductive titanium oxide which has high color stability at high temperature, its manufacturing method, and a plastic composition containing it.

Means to solve the problems

An anatase titanium oxide powder with zinc and/or aluminum contained in the crystal is used. In a solution of antimony-containing tin compound or a solution of tin-containing indium compound, a precipitate is formed as an electroconductive coating on the surface of the aforementioned titanium oxide powder. Then, by means of sintering, an anatase titanium oxide

having an electroconductive coating on its surface and containing zinc or aluminum is obtained.

Claims

1. Electroconductive titanium oxide characterized by the fact that an electroconductive coating made of metal oxide is formed on the surface of anatase titanium oxide with zinc and/or aluminum contained in the crystal.

2. The electroconductive titanium oxide described in Claim 1 characterized by the fact that the electroconductive coating is a tin oxide coating doped with antimony in an amount of oxide equivalence in the range of 5-20 wt%.

3. The electroconductive titanium oxide described in Claim 1 characterized by the fact that the electroconductive coating is an indium oxide coating doped with tin in an amount of oxide equivalence in the range of 5-20 wt%.

4. The electroconductive titanium oxide described in any of Claims 1-3 characterized by the fact that 0.05-1.0 wt% zinc is contained in the crystal.

5. The electroconductive titanium oxide described in any of Claims 1-3 characterized by the fact that 0.02-0.4 wt% aluminum is contained in the crystal.

6. The electroconductive titanium oxide described in any of Claims 1-5 characterized by the fact that the content of titanium oxide is 80 wt% or larger.

7. A plastic composition containing electroconductive titanium oxide characterized by the fact that it has one or several of the electroconductive titanium oxides described in any of Claims 1-6 blended in it.

8. The plastic composition described in Claim 7 characterized by the fact that the plastics refer to one or several of polyolefin, polyethylene terephthalate, polyvinyl chloride, nylon, acrylic resin, melamine and polycarbonate.

9. The plastic composition described in Claim 7 or 8 characterized by the fact that the plastic composition is in the form of granules for use as a master batch or coloring compound, or a molding, such as film, fiber, plate, or rod.

10. The plastic composition described in any of Claims 7-9 characterized by the fact that the plastic composition is in the form of a solution dispersed in a solvent, a paint dispersed in a coating forming agent, or an ink composition.

11. A manufacturing method for electroconductive titanium oxide characterized by the following facts: anatase titanium oxide powder with zinc and/or aluminum contained in the crystal is dispersed to form a suspension; the suspension is mixed with a solution of water soluble compounds of tin and antimony prepared with 5-20 wt% (oxide equivalent amount) antimony in tin oxide, and the liquid properties of the mixed solution are adjusted, so as to form a coating of antimony-containing tin compound on the surface of the titanium oxide powder; then, the titanium oxide powder is recovered, dried and sintered, so that the antimony-containing tin compound is made to adhere to the surface of the titanium oxide powder to form the electroconductive powder.

12. A manufacturing method for electroconductive titanium oxide characterized by the following facts. Anatase titanium oxide powder with zinc and/or aluminum contained in the crystal is dispersed to form a suspension; the suspension is mixed with

a solution of water soluble compounds of indium and tim prepared with 5-20 wt% (oxide equivalent amount) tin in indium oxide, and the liquid properties of the mixed solution are adjusted, so as to form a coating of tin-containing indium compound on the surface of the titanium oxide powder; then, the titanium oxide powder is recovered, dried and sintered, so that the tin-containing indium compound is made to adhere to the surface of the titanium oxide powder to form the electroconductive powder.

13. The manufacturing method described in Claim 11 or 12 characterized by the fact that the anatase titanium oxide powder is previously dispersed in an alkali aqueous solution, and the aforementioned solution of water soluble compounds of tin and antimony or the aforementioned solution of water soluble compounds of indium and tin is added into the suspension.

Detailed explanation of the invention

[0001]

Technical field of the invention

This invention pertains to a white electroconductive anatase titanium oxide powder which has little discoloration at high temperature and has excellent light resistance and weatherability. According to this invention, anatase titanium oxide refers to material containing 80% or more anatase crystal.

[0002]

Prior art

White electroconductive powder is widely used in manufacturing clean-room clothing used in the semiconductor manufacturing field, as well as in facility walls, floors, carpets, etc. At present, the main white electroconductive powders in use include tin oxide powder and rutile titanium oxide powder with an electroconductive coating formed on its surface. However, these white electroconductive powders do not have sufficient heat resistance, and there is margin for improvement in the hue and whiteness.

[0003]

On the other hand, as far as titanium dioxide is concerned, in addition to the conventionally used rutile crystal, there is also an anatase crystal with a low-temperature stable phase. This anatase titanium dioxide differs from the rutile type in that it has a bluish white color. Anatase titanium dioxide is usually manufactured by means of the sulfuric acid method. However, the conventional anatase titanium dioxide powder manufactured using the sulfuric acid method is more prone to discoloration at high temperatures, and it has poorer light resistance and weatherability compared with rutile titanium dioxide.

[0004]

Anatase titanium dioxide with little discoloration at high temperature and with excellent light resistance and weatherability has been developed by doping a small amount of zinc and/or aluminum into crystals of the anatase titanium dioxide (Japanese Patent Application Nos. Hei 7[1995]-351283 and Hei 8[1996]-142052).

[0005]

Problems to be solved by the invention

The purpose of this invention is to solve the aforementioned problems of the conventional white electroconductive powder by providing a white electroconductive titanium dioxide characterized by the fact that it is prepared by using the aforementioned anatase titanium dioxide doped with zinc or aluminum and by forming an electroconductive coating on its surface. The purpose of this invention is to provide a white electroconductive powder which is barely discolored at high temperatures, has excellent light resistance and weatherability, has a bluish white hue, a high whiteness, and excellent transparency. In the following, the properties of minimal discoloration at a high temperatures and excellent light resistance and weatherability will be referred to as "high color stability," and titanium dioxide will be referred to as titanium oxide.

[0006]

Means to solve the problems

That is, this invention pertains to an electroconductive titanium oxide with the following features.

(1) A type of electroconductive titanium oxide characterized by the fact that an electroconductive coating made of metal oxide is formed on the surface of anatase titanium oxide with zinc and/or aluminum contained in the crystal. The aforementioned electroconductive titanium oxide has a more stable crystal than conventional anatase titanium dioxide. Consequently, the adhesion of the electroconductive coating is improved, and the electroconductivity is good. Also, since the aforementioned electroconductive titanium oxide has high color stability at high temperature, blending in plastics at high temperature and high-temperature processing of the plastic compositions containing it is allowable.

[0007]

The preferable metal oxide electroconductive coatings that cover the surface of the aforementioned electroconductive titanium oxide include (2) a tin oxide coating doped with antimony in an amount in the range of 5-20 wt%, and (3) an indium oxide coating doped with tin in an amount in the range of 5-20 wt%. Because said antimony-containing tin oxide and tin-containing indium oxide have high electroconductivity and a coating of such oxides is formed on the surface of the

aforementioned titanium dioxide, it is possible to obtain a titanium dioxide powder with excellent electroconductivity.

[0008]

As far as the amount of zinc or aluminum introduced into the aforementioned anatase titanium dioxide is concerned, it is preferred that (4) 0.05-1.0 wt% of zinc be introduced or (5) 0.02-0.4 wt% of aluminum be introduced. Also, for the electroconductive titanium oxide powder of this invention, (6) the content of titanium dioxide should be 80 wt% or greater in said (1)-(5).

[0009]

Also, this invention pertains to a plastic compositions containing electroconductive titanium oxide with the following features. (7) A plastic composition containing electroconductive titanium oxide characterized by the fact that it has one or several of the electroconductive titanium oxides described in any of said (1)-(6) blended in it. As conventional plastic compositions have a high color stability at a high temperature, molding, spinning, and other processing operations at a temperature higher than that in the prior art are allowable. Also, as the aforementioned titanium dioxide powder exhibits lower shielding and higher transparency than rutile titanium dioxide powder, it is easier to perform dyeing and to adjust the hue of the plastics.

[0010]

(8) The plastic composition contains one or several of polyolefin, polyethylene terephthalate, polyvinyl chloride, nylon, acrylic resin, melamine and polycarbonate. (9) The plastic composition is in the form of granules for use as a master batch or coloring compound, or a molding, such as film, fiber, plate, or rod. (10) The plastic composition may also be in the form of a solution dispersed in a solvent, a paint dispersed in a coating forming agent, or an ink composition.

[0011]

In addition, this invention also provides a manufacturing method for electroconductive titanium oxide with the following features. (11) A manufacturing method for electroconductive titanium oxide characterized by the following facts: anatase titanium oxide powder with zinc and/or aluminum contained in the crystal is dispersed to form a suspension; the suspension is mixed with a solution of water soluble compounds of tin and antimony prepared with 5-20 wt% (oxide equivalent amount) antimony in tin oxide, and the liquid properties of the mixed solution adjusted, so as to form a coating of antimony-containing tin compound on the surface of the titanium oxide powder; then, the titanium oxide powder is recovered, dried and sintered, so that the antimony-containing tin compound is made to adhere to the surface of the titanium oxide powder to form the electroconductive powder.

[0012]

In the manufacturing method of electroconductive titanium oxide in this invention, instead of the aforementioned solution of the water soluble compounds of tin and antimony, (12) it is also possible to use a solution of water soluble compounds of indium and tin prepared with 5-20 wt% tin in oxide equivalence in indium oxide. Also, (13) the manufacturing method may also be carried out as follows: the anatase titanium oxide powder is previously dispersed in an alkali aqueous solution, and the aforementioned solution of water soluble compounds of tin and antimony or the aforementioned solution of water soluble compounds of indium and tin is added into the suspension. By using this manufacturing method, an electroconductive antimony-containing tin coatng or a tin-containing indium coating is formed on the surface of the aforementioned anatase titanium oxide powder, so that the electroconductive titanium dioxide powder of this invention is obtained easily.

[0013]

Embodiment

(I) Electroconductive titanium oxide

For the electroconductive titanium oxide in this invention, anatase titanium dioxide with zinc and/or aluminum contained in the crystal is used. Anatase titanium dioxide is a crystal having covalent bonds stronger than those of rutile titanium dioxide. It is believed that free electrons generated by crystal

defects are the cause of discoloration. Zinc and aluminum have ion radii similar to that of titanium. Since zinc or aluminum is contained in the titanium crystal, crystal defects can be eliminated, so that crystal stability and high temperature color stability are improved.

[0014]

As far as the amount of aluminum and/or zinc introduced into the crystal is concerned, the amount of aluminum ions should be in the range of 0.02-0.4 wt%, or preferably in the range of 0.04-0.3 wt%, and amount of zinc ions should be in the range of 0.05-1.0 wt%, or preferably in the range of 0.1-0.6 wt%. When both aluminum and zinc are used, the total amount of these ions should be in the range of 0.02-1.0 wt%, or preferably in the range of 0.04-0.6 wt%. Among them, the amount of aluminum should be 0.4 wt% or less. If the amount of zinc or aluminum introduced is less than the aforementioned range, the effect in improving the chemical stability of titanium dioxide is insufficient. Also, if the amount is larger than the aforementioned range, a free state of aluminum and zinc oxide exists that does not enter the crystal but is mixed with titanium dioxide. Consequently, the properties of the pigment, such as shielding ability, whiteness, etc., deteriorate, and this is undesirable.

[0015]

Also, the upper limit of the doping amount of aluminum is about half the amount of zinc. For aluminum, if the amount added

is too large, the particles are prone to blocking, and the dispersion property required for pigments deteriorates. For zinc, this tendency is less significant. Aluminum and zinc, in addition to being contained inside the crystal, may also be attached on the surface of particles. However, according to this invention, the amount of aluminum and the amount of zinc added are appropriate for introduction into the titanium dioxide crystal. There is no excess for attachment to the surface of particles.

[0016]

The aforementioned anatase titanium oxide doped with zinc or aluminum may be manufactured by adding a prescribed amount of aluminum compound and/or zinc compound into hydrated titanium dioxide obtained by hydrolysis of titanium sulfate, followed by sintering. Addition of the aluminum compound and/or zinc compound may be carried out by adding a solution prepared from a water soluble aluminum compound and/or a water soluble zinc compound in a slurry of hydrated titanium dioxide, or by drying hydrated titanium dioxide and mixing the obtained titanium dioxide powder with aluminum compound powder and/or zinc compound powder. The amount added should be appropriate so that the final amount of aluminum or zinc contained in the titanium oxide crystal is the aforementioned doping amount. By sintering the mixture of titanium dioxide and the aluminum compound or zinc compound at 850-1100°C, it is possible to obtain the aforementioned anatase titanium oxide with the aforementioned prescribed amount of aluminum or zinc contained in the crystal.

[0017]

For the aforementioned anatase titanium dioxide, the mean particle size of most particles should be in the range of 0.01-1.0 μm. If the mean particle size of most particles is smaller than 0.01 μm, the proportion of the surface with high free energy with respect to all particles increases, and it becomes chemically instable. On the other hand, if the particle size is larger than 1.0 μm, it becomes impossible to maintain the basic properties needed for the pigment. In order to obtain titanium dioxide particles with the correct mean particle size for most particles, when the sulfuric acid method is used, the precipitation conditions should be controlled for hydrolysis of titanium sulfate, or the temperature in the sintering operation after the hydrolysis may be controlled.

[0018]

As the electroconductive coating made of metal oxide and coated on the surface of the aforementioned titanium dioxide powder, it is preferred that a tin oxide coating doped with 5-20 wt% (oxide equivalent) of antimony or an indium oxide coating doped with 5-20 wt% (oxide equivalent) of tin be used. As antimony-containing tin oxide and tin-containing indium oxide have high electroconductivity, by forming their coating on the surface of titanium oxide, it is possible to obtain electroconductive titanium oxide powder. Also, for the antimony-containing tin oxide, if the doping amount of antimony is smaller than 5 wt% or larger than 20 wt%, the effect in increasing the electroconductivity decreases. And for the

tin-containing indium oxide, if the doping amount of tin is less than 5 wt% or larger than 20 wt%, the effect in increasing the electroconductivity decreases. Consequently, it is preferred that the doping amount of antimony or tin be maintained within the aforementioned ranges. The application state that these electroconductive coatings that cover the surface of titanium oxide is significant. The proportion [of covering] with respect to titanium oxide is about 5-25 wt%.

[0019]

When the amount of the electroconductive titanium oxide of this invention is over about 80 wt% with respect to the total amount of titanium oxide powder, the overall titanium oxide powder can be used as an electroconductive powder. Also, as long as the content of the electroconductive titanium oxide powder of this invention in the overall titanium oxide powder is more than about 80 wt%, even if conventional electroconductive powder made of tin oxide or rutile titanium oxide is added, there is still no significant degradation of the effects of this invention.

[0020]

The aforementioned electroconductive titanium oxide in this invention has a prescribed amount of zinc or aluminum doped in the crystal of titanium oxide, so that there are few crystal defects. Consequently, high-temperature color stability is particularly excellent, and there is little discoloration even after a long period of time. In addition, since the crystal is anatase, it is possible to obtain a bluish white powder with a

high whiteness. More specifically, since conventional anatase titanium [oxide] is prone to discoloration at high temperatures over 300°C, when it is blended with a plastic material, blending has to be carried out at a low temperature. On the other hand, for the aforementioned electroconductive titanium oxide powder of this invention, blending as well as spinning or other molding processing may be carried out at a high temperature over 300°C. Also, since the powder has excellent electroconductivity, it can be used widely as a white electroconductive material in high-temperature applications for which discoloration has been a problem. In addition, since the electroconductive coating adheres tightly to the surface of the powder, high electroconductivity can be realized, and, even after long-term use, good electroconductivity is still be maintained.

[0021]

(II) Method for manufacturing the electroconductive titanium oxide

The electroconductive titanium oxide in this invention is manufactured from the aforementioned anatase titanium oxide powder with zinc or aluminum contained in the crystal. As shown in the manufacturing process presented below, a composition that acts as the aforementioned electroconductive coating is formed by precipitation from a solution onto the surface of the aforementioned powder, followed by sintering.

[0022]

(A) Preparation of the suspension of the titanium oxide powder

In order to form the electroconductive coating uniformly on all of the powder, one may disperse the anatase titanium oxide powder in an aqueous solution to form a suspension in advance. As the coating feed material, tin chloride solution may be used, and, by means of its neutralization, a precipitate of the coating composition is formed. In this case, one may previously adjust the suspension of the titanium oxide powder to [an] alkaline [pH]. The anatase titanium oxide powder used has a prescribed amount of zinc or aluminum contained in it as explained above.

[0023]

(B) Preparation of electroconductive coating solution

When a tin oxide type electroconductive coating is to be formed, a mixed solution of water soluble tin compound and water soluble antimony compound containing 5-20 wt% (oxide equivalent) antimony in tin oxide is used. On the other hand, when an indium oxide coating is to be formed, a mixed solution of water soluble indium compound and water soluble tin compound containing 5-20 wt% (oxide equivalent) tin in indium oxide is used. Examples of water soluble tin compounds, antimony compounds, and indium compounds include tin chloride, antimony chloride, indium chloride, and other chlorides, as well as sulfates, nitrates, etc. For example, when a tin oxide coating is to be formed, one may use a solution, such as a solution prepared using a water

soluble solvent or an aqueous solution of hydrochloric acid, prepared by adding 80-95 wt% tin chloride and 5-20 wt% antimony chloride, as well as ethanol, etc., added as needed. On the other hand, when an indium oxide coating is to be formed, one may make use of a solution, such as a solution prepared using a water soluble solvent or an aqueous solution of hydrochloric acid, prepared by adding 85-95 wt% indium chloride and 5-15 wt% tin chloride, as well as ethanol, etc., added as needed.

[0024]

(C) Formation of coating precipitate

The aforementioned titanium oxide suspension and electroconductive coating solution are mixed, and the liquid properties of the mixture solution, such as pH and solution temperature, etc., are adjusted, so that a coating of an antimony-containing tin compound or tin-containing indium compound can be formed as a precipitate on the surface of the titanium oxide powder. The compound is mainly a hydrated oxide. More specifically, when an acidic solution of tin chloride containing antimony is added into the titanium oxide suspension together with an aqueous alkali solution, such as caustic soda, etc., so that pH is neutralized to 1-4, a hydrated oxide is formed, and a coating is formed on the surface of the titanium oxide powder in the form of a precipitate of a hydrated oxide containing antimony. As the hydrated oxide is sintered in the next step of operation, it becomes a tin oxide coating adhered on the surface of the powder. In another method, the titanium oxide suspension is heated to higher than 90°C, and the aforementioned acidic solution of tin chloride is added together

with an alkaline aqueous solution of caustic soda, etc., under stirring, so that the solution is neutralized to pH 9 or higher, and a coating is formed directly as a precipitate of tin oxide. By recovering titanium oxide powder with a coating and sintering it, an electroconductive powder with the aforementioned tin oxide coating adhering to it is obtained. Also, it is possible to form a coating of indium oxide containing tin in the same way. Since the tin oxide coating and indium oxide coating are thin and transparent, the white color of titanium oxide as the base appears, so that the powder obtained has a white color.

[0025]

(D) Drying and sintering

The titanium oxide powder with a coating formed by a precipitate of hydroxide or oxide is recovered by solid-liquid separation, and is washed if needed. This is followed by drying and sintering in air at 500-800°C for 1-2 h to form the desired electroconductive titanium oxide powder. By means of this sintering operation, the hydroxide coating becomes an oxide coating adhering to the surface of the powder. In another method, after the coating is formed as an oxide precipitate, sintering is performed to further dehydrate so as to obtain a coating adhered to the surface of the powder. If the sintering temperature is lower than 500°C, sintering is insufficient. On the other hand, if the heating temperature is higher than 800°C, significant coagulation takes place, and the dispersion property deteriorates. This is undesirable. The sintering time is about 1-2 h.

[0026]

(E) Electroconductivity of obtained titanium oxide

Using the aforementioned manufacturing method, it is possible to obtain an electroconductive titanium oxide powder with a stable coating of tin oxide containing a prescribed amount of antimony or a stable coating of indium oxide containing tin on the surface of the powder. The electroconductivity of the obtained titanium oxide depends on the type, composition and thickness of the electroconductive coating on the surface. Usually, as suggested by the application examples to be presented later, the resistivity is in the range of 1-100 Ω-cm.

[0027]

(III) Plastic composition

The aforementioned electroconductive titanium oxide powder can be used preferably as a white electroconductive material for addition into a plastic composition. The plastic composition containing the aforementioned electroconductive titanium oxide powder is included in this invention. The electroconductive titanium oxide used in this case may be the electroconductive titanium oxide powder having the antimony-containing tin oxide coating or the electroconductive titanium oxide powder having the tin-containing indium oxide coating, which may be used alone or as a mixture of several types. The amount of the aforementioned electroconductive titanium oxide added depends on the specific application of the plastic composition, the degree

of electroconductivity, the form of application, etc. Also, there is no special limit on the method for blending the aforementioned titanium oxide into the plastic composition or on the method for processing the obtained plastic composition.

[0028]

Various plastics may be used, such as polyolefin, polyethylene terephthalate, polyvinyl chloride, nylon, acrylic resin, melamins and polycarbonate. They may be used alone or as a mixture of several types.

[0029]

There is no special limit on the form of use of the aforementioned plastic composition containing electroconductive titanium oxide. The forms that may be adopted include granules for use as a master batch or coloring compound, and moldings, such as film, fiber, plate, or rod, as well as the form of a solution dispersed in a solvent, a paint dispersed in a coating forming agent, or an ink composition.

[0030]

Application examples

Application Example 1

100 g of anatase titanium oxide powder containing 0.07 wt% aluminum (Al) were added to 1,000 mL of water. While being stirred, the mixture was heated to 90°C and was maintained at this temperature to form a suspension with the titanium oxide powder dispersed homogeneously in it. A solution prepared by dissolving 8.7 g of tin chloride ($SnCl_4$) and 0.5 g of antimony chloride ($SbCl_3$) in 300 mL of ethanol was added into the heated suspension over 2 h. The mixture was kept at pH 2-3, so that a precipitate of hydrated tin oxide containing Sb was formed on the surface of the aforementioned titanium oxide powder, with this precipitate acting as a coating layer. Then, the solution was washed, and the aforementioned titanium oxide powder was recovered by filtering. After drying, the titanium oxide powder was heated in air at 500°C for 2 h, forming a white anatase titanium dioxide powder having a coating formed on its surface. The coating on the surface of the powder is made of tin oxide (SnO_2) containing 5 wt% Sb. It is a composite titanium dioxide powder having a resistivity of 100 Ω-cm.

[0031]

Application Example 2

100 g of anatase titanium oxide powder containing 0.06 wt% aluminum (Al) were added into 1,000 mL of a 50% aqueous solution of sulfuric acid. While being stirred, the mixture was kept at 50°C to dissolve impurities other than titanium oxide. After washing, water was added to make 1,000 mL. While being stirred, the mixture was heated to 95°C, so that the titanium oxide powder was homogeneously dispersed to form a suspension. A solution prepared by dissolving 32 g of tin chloride ($SnCl_4$) and 7 g of antimony chloride ($SbCl_3$) in 400 mL of a 6-N aqueous solution of hydrochloric acid was added into the heated suspension over 2 h, while a 30% aqueous solution of caustic soda was added at the same time to maintain the pH at 3 or lower. A precipitate of hydrated tin oxide containing Sb was formed on the surface of the aforementioned titanium oxide powder as a coating layer. Then, the solution was washed, and the aforementioned titanium oxide powder was recovered by filtering. After drying, the titanium oxide powder was heated in air at 600°C for 2 h, forming a white anatase titanium dioxide powder having a coating formed on its surface. The coating on the surface of the powder is made of tin oxide (SnO_2) containing 19 wt% Sb. It is a composite titanium dioxide powder having a resistivity of 90 Ω-cm.

[0032]

Application Example 3

100 g of anatase titanium oxide compound powder containing 0.06 wt% aluminum (Al) were added into 1,000 mL of a 50% aqueous solution of sulfuric acid. While being stirred, the mixture was kept at 50°C to dissolve impurities other than titanium oxide. After washing, water was added to make 300 mL. While being stirred, the mixture was heated to 90°C, so that the titanium oxide powder was homogeneously dispersed to form a suspension. A solution prepared by dissolving 30 g of tin chloride ($SnCl_4$) and 4.5 g of antimony chloride ($SbCl_3$) in 100 mL of a 6-N aqueous solution of hydrochloric acid was added into the heated suspension over 1 h, while a 15% aqueous solution of caustic soda was added at the same time to maintain the pH in the range of 1-4. A precipitate of hydrated tin oxide containing Sb was formed on the surface of the aforementioned titanium oxide powder as a coating layer. Then, the solution was washed, and the aforementioned titanium oxide powder was recovered by filtering. After drying, the titanium oxide powder was heated in air at 600°C for 1 h, forming a white anatase titanium dioxide powder having a coating formed on its surface. The coating on the surface of the powder is made of tin oxide (SnO_2) containing 12 wt% Sb. It is a composite titanium dioxide powder having a resistivity of 50 Ω-cm.

[0033]

Application Example 4

100 g of anatase titanium oxide compound powder containing 0.06 wt% aluminum (Al) were added into 1,000 mL of a 50% aqueous solution of sulfuric acid. While being stirred, the mixture was kept at 50°C to dissolve the impurities other than titanium oxide. After washing, water was added to make 600 mL. While being stirred, the mixture was heated to 95°C, so that the titanium oxide powder was homogeneously dispersed to form a suspension. A solution prepared by dissolving 2 g of tin chloride ($SnCl_4$) and 22 g of indium chloride (InCl3) was added into the heated suspension over 1 h, while a 15% aqueous solution of caustic soda was added at the same time. A precipitate of hydrated indium oxide containing Sn was formed on the surface of the aforementioned titanium oxide powder as a coating layer. Then, the solution was washed, and the aforementioned titanium oxide powder was recovered by filtering. After drying, the titanium oxide powder was heated in air at 650°C for 2 h, forming a white anatase titanium dioxide powder having a coating formed on its surface. The coating on the surface of the powder is made of indium oxide (In_2O_3) containing 10 wt% Sn. It is a composite titanium dioxide powder having a resistivity of 12 Ω-cm.

[0034]

Effect of the invention

For the electroconductive titanium oxide of this invention, color stability at high temperature is particularly excellent. There is little discoloration even at a processing temperature higher than 300°C. Also, there is little discoloration or fading even after a long period of time. Consequently, it can be used as a white electroconductive material in high-temperature applications, which have been subject to discoloration, etc. Since the titanium oxide powder is anatase, the powder has a bluish white color with a high whiteness level. Also, its transparency is better than that of rutile titanium oxide. Besides, it has excellent electroconductivivty, and the electroconductive coating adheres tightly to the surface of the powder. Consequently, it is possible to realize high electroconductivity. Also, for the plastic composition containing the aforementioned electroconductive titanium oxide, discoloration barely occurs in high-temperature processing, and color stability in processing is excellent. For a colored plastic composition, high stability in processing and ease of dyeing are usually desirable. For example, for highly transparent polyester, the processing temperature is often over 300°C, and minimal discoloration is required even at such a high temperature. The plastic composition of this invention meets this requirement. Also, the white color of the white electroconductive powder can be seen through the layer of the electroconductive coating. Consequently, the color stability and heat resistance of the base titanium oxide are important. The

electroconductive titanium oxide of this invention has a higher color stability than that of the conventional anatase titanium oxide and rutile titanium oxide. In addition, since the plastic composition containing electroconductive titanium oxide of this invention has a bluish white color and low shielding properties, the hue after coloration is much better than that of the conventional type. For example, as the conventional rutile titanium oxide powder has a high shielding power, when it is mixed with another color, the hue decreases, with white turbid saturation. On the other hand, for the electroconductive titanium oxide powder of this invention, there is no such problem, and a good hue with excellent color balance can be realized.

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